DEVELOPMENT OF CALCIUM-BASED SORBENT FOR HOT GAS CLEANUP

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Abstract

The main objective of this project is the development of a superior calcium-based sorbent for hot gas cleanup in integrated coal gasification, combined-cycle (IGCC) power generation systems. The sorbent should be capable of removing H_2S and COS from hot coal gas and should withstand repeated loading and regeneration.

Various methods are being employed for preparing potential sorbents. One method involves impregnating porous refractory substrates with calcium oxide. A second method involves reacting mixtures of calcium oxide and silica at high temperature to form a composite material consisting of both dicalcium silicate and unreacted or "free" calcium oxide. A third method involves pelletizing Portland cement or mixtures of limestone and cement followed by curing under moist conditions. The prepared materials are characterized by measuring their compressive strength, apparent porosity, and ability to adsorb H_2S at high temperature. Materials which pass initial screening tests are subjected to repeated loading and regeneration and additional testing for compressive strength.

A promising sorbent has been prepared by pressing an appropriate mixture of calcium oxide and silica powders to form small briquettes which then have been heated to 900 to 1000°C to produce a $CaO{\cdot}Ca_2SiO_4$ composite. Some starch is incorporated in the briquettes to create a porous structure on burn out. Also some B_2O_3 is incorporated to stabilize the α-Ca_2SiO_4 which forms at high temperature. The product has exhibited moderate compressive strength and has proved capable of adsorbing up to 14% of its weight in 1.0 hr. when exposed to a gas stream containing 1.1% H_2S at 880°C.

Another promising material has been prepared by pelletizing powdered limestone and Portland cement followed by steam curing. This material has also exhibited moderate compressive strength and has proved capable of adsorbing up to 13% of its weight in 1.0 hr. when exposed to a gas stream containing 1.1% H_2S at 1000°C. Other materials prepared by pelletizing and curing Portland cement alone exhibited greater compressive strength but reduced capacity for adsorption.

Attempts to prepare a sorbent by impregnating a porous alumina substrate with calcium oxide have been less successful. Several commercially available catalyst carriers made of alumina have been impregnated with amounts of calcium oxide ranging up to 20% of the weight of the carrier. However, none of the products have proved capable of adsorbing more than 2% of their weight when exposed to H_2S in low concentration at high temperature.

Future work will focus on developing the necessary traits of a good sorbent and the relationship between these traits and sorbent preparation conditions. These traits include high adsorption capacity, adequate compressive strength, and the ability to withstand repeated loading and regeneration.

Future Presentations

T. Akiti and T. D. Wheelock, "Development and testing of Portland cement based sorbents for hot gas cleanup," annual meeting of the Iowa Academy of Science, Mason City, Iowa, April 25, 1998.

J. Zhu and K. P. Constant, "Development of impregnated alumina with calcium nitrate for hot gas cleanup," annual meeting of the Iowa Academy of Science, Mason City, Iowa, April 25, 1998.

Graduate Students Receiving Support

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1997 Summer Interns

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